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Providing Product-Service-Systems - The Long Way from a Product OEM towards an Original Solution Provider (OSP)

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Abstract

Product-Service-Systems (PSS) have gained tremendous attention in research and industry over the past years [1-4]. Manufacturing firms transform from providing pure products towards providing integrated products and services [2]. This development is triggered by the increasing customer demand for PSS and the opportunity of manufacturers to differentiate themselves from their competitors as services are hard to replicate. For providing PSS companies need to go through fundamental changes which range from organizational adaptions within the company structure over novel development processes to improving the customer relationship. In this paper the authors describe requirements for providing PSS which were derived from a case study with a crane manufacturer and an extensive literature research. These requirements are considered with respect to the different PSS business models related to the PSS types defined by Tukker [5]. Furthermore the implementation of one of these requirements in the case company is described.

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Keywords: Product-Service Systems; Original Solution Provider; Change Management; Transformation, PSS business model

1. Introduction

In the present market environment many enterprises see themselves confronted with an increasing demand for lifecycle spanning solutions which consist of products and integrated services. To stay competitive companies need to meet this demand by offering PSS [6]. Thus it is necessary for them to transform from product OEM towards an OSP. To become an OSP fundamental changes depending on current circumstances within the enterprise and the environment are required. These changes range from organizational adaptions within the company structure over novel development processes to improving the customer relationship.

Even though ongoing research focuses on the concept of PSS, economic and environmental potential of PSS as well as evolving methods and tools supporting the development [3,4] and virtual validation of PSS [7-10] a comprehensive framework providing all requirements for the three PSS business models related to the PSS types proposed by Tukker [5] which represent the most common PSS classifications [3] is still missing. As the knowledge of these requirements is the first step to enable enterprises to operate these PSS business models further research in this field is required. The PSS types with its respective offerings are described in the following:

- Product-oriented services (provided in a function-oriented PSS business model): product, product related services as well as advice and consultancy
- Use-oriented services (provided in an availability-oriented PSS business model): product lease, product renting and product pooling
- Result-oriented services (provided in a result-oriented PSS business model): activity management, pay per service unit and functional result

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To close this gap a use case analysis in collaboration with a material handling manufacturer was conducted within the transfer project "PSS system design and process based project management in development" of the collaborative research center Transregio 29. In this project the material handling manufacturer is currently facing the challenges of becoming an OSP and thus represents an optimal research partner. To derive the requirements, the prevailing company situation was analyzed through interviews and document analysis with regard to the necessary changes for developing and providing a novel PSS.

In addition to the use case analysis accompanying impulses from discussions with other Transregio 29 partners and an extensive literature research served as input. In this paper the authors give an overview over the requirements and describe the organizational, cultural and customer specific aspects as well as required changes in the development process to enable an integrated design of products and services. Thereby the authors focus on the three PSS business models related to the PSS types proposed by Tukker [5].

2. Research approach

The research approach divides into an extensive literature research, a case study and accompanying discussions with other researchers form the collaborative research center Transregio 29. In chapter 3 the authors introduce four studies dealing with the challenges of the transition from a pure product OEM towards an OSP. The identified requirements from the literature research were assigned to the appropriate PSS business model and are presented in chapter 3.1. Thereby the requirements of a less service-oriented PSS business model are essential for a more service-oriented PSS business model. For example: The requirements for operating a function-oriented PSS business model are also driving requirements for operating an availability-oriented PSS business model. In chapter 3 the design of the case study as well as the thereby identified requirement are described. These requirements complete the before identified requirements from literature research. In chapter 4 the implementation of one of these requirements in the case company is described.

3. Literature research

The basis of the literature research was formed by 779 findings searching the Google Scholar database for the terms "product service system" and "servitization". These findings were manually checked by reviewing title and abstract. The authors identified four of these studies as extremely important for defining the requirements for operating the different PSS business models and therefore will describe these in more detail.

Oliva and Kallenberg focus in their elaboration on services relating to a product's installed base and describe a process model for developing these services [11]. This process model divides into the following four stages and defines concrete triggers, goals and actions for the first three stages:

- Consolidating product-related services
- Entering the installed based service market
- Expanding to relationship-based and process-centered services
- Taking over the end-user's operation

The first two stages discuss challenges in operating a function-oriented PSS business model as the third stage approaches the transition towards an availability-oriented PSS business model. Oliva and Kallenberg give no further insight on the last stage which can be compared to the operation of a result-oriented PSS business model. They propose that *"this is a transition that most manufacturing firms probably will not initiate soon"*.

Leseure et al. carried out a case study with an OSP and two of its suppliers in which a total of 22 interviews with senior managers were conducted. The authors identified several challenges during the servitization progress and summarized them in five key issues [12]:

- Embedded product-service culture
- Delivery of integrated offering
- Internal processes and capabilities
- Strategic alignment
- Supplier relationship

These five key issues focus on the transition towards operating a function-oriented PSS business model and do not address any challenges specific to the other two PSS business models.

Gebauer et al. derive success factors for increasing service revenues of manufacturing companies from a benchmarking project and provide appropriate steps for implementing these success factors [12]:

- Marketing-oriented service development and clearly defined service development process
- Service offering focusing on the value proposition to the customer (product related services and services supporting the customer)
- Relationship marketing
- Service strategy
- Separate service organization
- Service culture

Gebauer et al. also do not address any challenges specific to an availability- or result-oriented PSS business model.

Elfving et al. focus on the servitization process in the information and communication technology sector. They analyze the organizational challenges and possible solutions within the context of a case study in cooperation with a company of the telecommunication industry [14]. No specific aspects of operating an availability- or result-oriented PSS business model are addressed.

In sum, existing research about transformation from product OEM towards an OSP focuses on the operation of a function-oriented PSS business model. Solely Oliva and Kallenberg discuss some of the challenges in operating an availability-oriented PSS business model. No research

focusing on requirements in operating a result-oriented PSS business model could be identified.

2.1 Identified requirements from literature research

Most existing literature focuses on the transition towards operating a function-oriented PSS business model (cf. chapter 3). At first, a service strategy is necessary to build the basis for a successful transformation and derive the targets for the operational business. To define a successful service strategy it is essential to integrate all involved parties in the definition of the service strategy and consider customer requirements, market potential and future service trends [13].

The change from product-oriented to product- and service-oriented corporate culture enables companies to meet customer expectations [11]. The change in the culture should also occur on the management level to enable the change on the employee level whereby the mindset of an integrated offering of products and services is essential [12].

Additionally companies need a separate service organization which is responsible for all services and operates as a profit center with profit and loss responsibility [11, 13]. For this service organization separate goals and quantifiable targets should be defined [13, 14]. A monitoring system for checking the service quality and service fulfillments should be implemented to control target compliance [13, 14].

Furthermore internal service development processes as well as easy to use methods for developing a PSS must be implemented [9]. Additionally product and service design processes need to be integrated to enable the provision of an integrated offering [13].

Providing a function-oriented PSS business model requires a relationship marketing to ensure a long collaboration between provider and customer. The long relationship is also required to generate the expected revenues within the function-oriented PSS business model [13]. The implementation of a service infrastructure is necessary to satisfy all customer requirements by providing the services where they are needed [11].

The availability-oriented PSS business model is more complex than the function-oriented PSS business model and the OSP has more responsibility. Thus further requirements become important to operate this kind of PSS business model. Oliva and Kallenberg discussed some of these requirements in their journal article from 2003. These will be summarized in the following before additional aspects from the case study will be added.

The main difference between the function-oriented PSS business model and the availability-oriented PSS business models is the transfer of the equipment's operating risk to the OSP. To calculate the price for providing the services to the customer the OSP has to analyze past data about the machine failure, consequential costs for services and spare parts, operating data as well as other investments for operating an availability-oriented PSS business model (cf. chapter 3.1). Thus the OSP requires the above mentioned information and the additional skills for risk and price calculation. This is not often the case within today's manufacturing companies [11].

All identified requirements from the literature research are illustrated in Table 1.

4. Case study

The objective of the case study which was carried out within one of the transfer projects of the collaborative research center Transregio 29 was to verify the requirements identified within the literature research as well as the internal Transregio 29 research and to identify missing requirements for providing an availability- or result-oriented PSS business model. Therefore, a document analysis and five guideline-based interviews were conducted. Interview partners ranged from service engineers over product development managers towards service technicians. The semi structured interview guides consisted of three main questions which focus on the service and product development, the organization structure and other aspects which could have impact on providing an availability- or result-oriented PSS business model.

The case company is a supplier of material handling equipment as well as services with production on five continents and its sales and service network operates in more than 60 countries. Over the last years it has transformed from a product centered company towards a provider of products and services. During this transformation the case company has managed several challenges. The corporate culture has changed from product oriented to a more service oriented mindset, services have become one pillar of their business strategy and a service company has been developed. Nowadays more than 30 percent of the sales result from services and services generate an even bigger share of the revenues.

Since the company is already providing many services its business model can be compared to a function-oriented PSS business model. The next step is the development of a novel PSS comprising the crane and proactive services to prevent unwanted downtimes. To enable the case company providing these services, operating data is recorded and automatically transferred by a remote system linked to the crane. In a next step this operating data will be analyzed to generate the needed knowledge for gaining the competence to provide the proactive services.

3.1 Identified requirements from the case study

All requirements from the literature research were confirmed in the case study. Besides these requirements further challenges were derived which will be described in the following. The first challenge identified is not the recording of the operating data but the availability of this data for the OSP. As this data legally belongs to the customer the OSP needs the customers allowance to record and use it. If the customer does not agree to share the operating data with the OSP the success of the availability-oriented PSS business models is jeopardized.

Without the operating data the OSP is not able to calculate the risk properly. Although the presence of data about past machine failure and consequential costs for services and spare parts would help the OSP with his calculations, the lack of

operating data would lead to inaccurate risk calculation, incorrect price models and consequently losses for the OSP. Besides risk calculation operating data is necessary for providing proactive services and thus optimizing maintenance intervals. Optimizing maintenance intervals by using operating data can prevent unwanted downtimes and reduce the costs for subsequent repairs. This is essential for the OSP because he has to cover the risk for unavailability of the machine and repair costs.

Furthermore operating data can be used to notice wrong machine usage and thus enable the initiation of counter actions. False usage could damage the machine and would also result in additional repair costs and unwanted downtimes. Another aspect in this field is that the OSP has the opportunity to prove that the machine damage is the result of a wrong machine usage and though does not have to pay for it if the contract excludes him in that situation.

Additionally analyzing the operating data helps to compensate a lack of communication between the customer and the OSP. If an argument within the production process changes and the customer does not inform the OSP he has no opportunity to adjust the machine settings to prevent machine failure. By analyzing the operating data the OSP would notice the changes within the production process and could inform the customer about the necessary machine adjustments. To enable the OSP to react in time the operating data must be recorded and transferred to the OSP as soon as possible, optimally in real time. In this context cyber-physical-systems could be of utmost importance for the OSP as these systems could perform changes to the machine settings automatically in case of changing process arguments.

Considering all the mentioned challenges the approval of the customer for the operating data usage is essential for operating an availability-oriented PSS business model. As most companies do not agree to provide their operating data for external usage, this is not a challenge which can be easily solved. To convince companies to do so a good and trustful relationship between customer and OSP is necessary. Otherwise the customer will fear that the OSP will use the data not only for issues concerning the operation of the availability-oriented PSS business model but to cause harm to him by passing the operating data to competitors or by using it for internal purposes.

This especially plays an important role if the OSP has business relationships with companies which are in direct competition to each other. In this case an extremely sensible handling of the data becomes necessary which requires a corresponding mindset of the employees on the side of the OSP. Even though this is a condition which employees in all companies should fulfill it is even more important for operating an availability-oriented PSS business model. Besides the aspect of a trustful relationship the problem of data security is important as well. Even if the customer trusts the OSP he will not provide him with the operating data if he is not sure that they are truly safe. This is an aspect which the OSP has to prove to the customer.

Consequently it is of utmost importance that the OSP and the customer have a trustful relationship and that the OSP can guarantee the security of the operating data.

If the OSP has the approval of the customer for using his operating data he needs the technology to record it. Even though companies already have the technology to capture some of the operating data it is questionable if this data provides enough information to generate the proactive services or if additional information is needed. Furthermore it needs to be considered that the capturing of the data takes place at the manufacturing hall of the customer. As it would be a huge effort to gather the collected data manually from the monitoring tool it is important that this tool has wireless data transfer functionality. Furthermore it needs to be considered that the customer does not want to pay for the monitoring system because he has no direct value of it [11]. Hence the costs for producing and operating the monitoring system must be low to ensure that the availability-oriented PSS business model can be operated profitable. Thus a cost-efficient monitoring system which transfers the data automatically and wireless is another requirement for operating an availability-oriented PSS business model.

A pure recording of the operating data is not enough as it spends no benefit to the OSP or the customer. The next step is to analyze this data to generate the needed knowledge for gaining the competence to provide proactive services. This is a demanding process which requires appropriate methods and know-how as well as time and thus human resources. After this initial analysis an automated process needs to be implemented to reduce the manual effort of the employees. For an automated analysis an appropriate IT tool is inalienable. Thus a first investment of human resources is necessary to analyze the operating data, derive proactive services and define appropriate processes as well as IT tools to automatically analyze the operating data.

In the case company operating data like the driven distance of the trolley or the number of overloads is available but there has been made no effort to structure the data so far. To perform safe actions, in this case providing proactive services for preventing unwanted downtimes, the operating data needs to be structured to information and transferred to knowledge to gain the competence for performing these safe actions. Figure 1 illustrates the correlation between data, information, knowledge, competence and safe actions.

Figure 1. The key enabler pyramid

Furthermore the operating data gives the OSP the opportunity to use this information in the product and service development to improve his offerings. This data contains extensive hints on the product behavior as well as service quality and gives important insight on how the customer uses the product. Improving product and services by using this information and thus compensating the additional cost for the analysis of the operating data is of utmost importance. Hence an adoption of the integrated product and service development processes becomes necessary to ensure the proper usage of the data.

In a result-oriented PSS business model the OSP is not only responsible for the availability of the machine but also for the operation. Thus he is responsible for all operating processes. As this gives more insight into the processes of the customer a good and trustful relationship becomes even more important when operating a result-oriented PSS business model.

Furthermore the employees of the OSP need a higher qualification than for operating an availability-oriented PSS business model. They are responsible for the production process which requires more technical knowledge. Summarizing, all requirements for the different PSS business models are illustrated in Table 1.

Table 1. Identified requirements from the case study and literature research

Requirements for operating a function-oriented PSS business model	Literature Research	Case study
Service strategy	X	X
Product- and service-oriented corporate culture	X	X
Separate service organization with profit and loss responsibility	X	X
Integrated product and service development process	X	X
Relationship marketing	X	X
Service infrastructure	X	X
Requirements for operating an availability-oriented PSS business model	**Literature Research**	**Case study**
Cost-effective monitoring tool for recording the operating data	X	X
Appropriate skills for analyzing the operating data	X	X
Wireless transfer of the operating data		X
Transfer of the operating data in real time		X
Trustful relationship to the customer		X
Data security		X
Allowance for using operating data		X
Sufficient resources for initial analysis of the operating data		X
Tool for automated data analysis		X
Appropriate processes to use the operating data in integrated product and service development		X
Requirements for operating a result-oriented PSS business model	**Literature Research**	**Case study**
Higher qualification of employees		X

5. Implementing an integrated product and service development process in the case company

After defining the requirements for operating the different PSS business models the question is how these requirements can be implemented in a company which wants to transform from product OEM towards an OSP. Since the implementation of all mentioned requirements would go beyond the scope of this paper, the implementation of only one requirement will be described.

As described in chapter 3, the case company already provides products as well as services and thus its business model can be compared to a function-oriented PSS business model. Nevertheless the case company does not fulfill all requirements for operating a function-oriented PSS business model. They defined a service strategy, have a product- and service-oriented corporate culture, have separate service organization with profit and loss responsibility and operate a service infrastructure. In contrast relationship marketing and an integrated product and service development process are still missing. In the following the authors describe the implementation of an integrated product and service development process in the case company by using the process for introducing PSS development knowledge by Nguyen et al. [15] and the method for operationalizing PSS development process by Nguyen et al. [16].

The first method describes a process for introducing new PSS methods to into industry which consists of the following four steps [15]:

- Analysis of the corporate culture
- Assignment of the needed knowledge to the involved players
- Introducing the assigned knowledge
- Establishment of a support role for the PSS development process

The method for operationalizing PSS development process supports potential OSP with defining an integrated product and service development process for a development project [16]. Furthermore, this method lays the foundation for implementing appropriate processes for using operating data in the integrated product and service development.

To successfully implement an integrated product and service development processes the first step was to analyze the existing approaches in the case company. The product development follows a well-established stage gate process. The development process is accepted by the employees as well as the project managers and they are familiar to a process oriented approach. Hence the product development approach is not dependent on the project manager. Even though the service department is integrated in some activities of the process, it is inappropriate to speak of an integrated product and service development yet. To guarantee a successful implementation of an integrated product and service development process, the development process of the method for operationalizing PSS development had to be integrated in the existing process. A radical change of existing structures would have hindered a successful implementation.

In contrast to the product development the service development approach is highly dependent on the project manager. There is no service development process defined and most of the employees and project managers are not used to work in processes. Thus it was important to train the fundamentals and benefits of a process based development to the people from the service development first before introducing the new method to ensure a successful implementation of an integrated product and service development process.

After analyzing the product and service development and training the service employees the method for operationalizing PSS development was introduced to the use company through a workshop with project managers from service and product development. In this workshop the participants learned the benefits and usage of the new method by an application example. In the following the method was used to plan the development process of an upcoming PSS development project. The research assistant of the transfer project assumes the support role for the PSS development process.

Currently the PSS development project is conducted with the purpose of evaluating the new integrated product and service development process. As this is still under progress the results will be published in future publications.

6. Conclusion and outlook

In this paper the authors described requirements for operating a PSS business model. These requirements were allocated to the three PSS business models related to the PSS types by Tukker [5].

The described requirements must be seen against the background of the following limitations. The use case is limited to one company whereby the derived requirements cannot be seen as absolute. Some of these requirements might not fit to companies from other branches and some requirements might be missing. Thus the mentioned requirements must be evaluated and completed in other use cases with companies from different branches.

Furthermore this paper describes the requirements but does not yet explain for all of them how they can be implemented in the industry. This is a very important aspect and should be an issue of future researches. Here existing disciplines as organizational change management [17-19] could provide valuable input. Additionally the time for transforming towards an OSP, the value of each requirement, the interactions between single requirements and the question if a transformation towards an OSP is lucrative for the company are aspects for future research which were not addressed in this paper.

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References

[1] Hou J, Neely A. Barriers of Servitization: Results of a Systematic Literature Review. Spring Servitization Conference. Aston University; 2013.

[2] Neely A, Benedetinni O, Visnjic I. The servitization of manufacturing: Further evidence. 18th European Operations Management Association Conference. Cambridge; 2011.

[3] Tukker A. (2013): Product services for a resource-efficient and circular economy - a review. Journal of Cleaner Production 2013; In Press, Corrected Proof. Available online 7 December 2013.

[4] Boehm M., Thomas O. Looking beyond the rim of one's teacup: a multidisciplinary literature review of Product-Service Systems in Information Systems, Business Management, and Engineering & Design. Journal of Cleaner Production 2013; 51:245-260

[5] Tukker A. Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet. Business Strategy and the Environment 2004; 13:246-260.

[6] Meier H., Uhlmann E. (ed.) (2012): Integrated industrial products and services. Springer, Berlin Heidelberg S. 1-6.

[7] Müller, P.; Stark, R. (ed.) (2010): A generic PSS Development Process Model based on theory and an empirical study. Dubrovnik, 17.05.2010.

[8] Müller, P.; Kebir, N.; Stark, R.; Blessing L. (2009): PSS layer method – application to microenergy systems. In: Sakao, T.; Lindahl, M. (Hrsg) Introduction to product/service-system design. Springer, Berlin

[9] Nguyen H N, Müller P, Stark R.: Transformation towards an IPS2 business: A deployment approach for process-based PSS development projects. Proceedings of 4th CIRP International Conference on Industrial Product-Service Systems, Tokyo; 2012.

[10] Exner K, Stark R. Validation of Product-Service Systems in Virtual Reality. In Brissaud D., Boucher X, editor. 7th Industrial Product-Service Systems Conference - PSS, industry transformation for sustainability and business. unpublished; 2015.

[11] Oliva R, Kallenberg R. Managing the transition from products to services. International Journal of Service Industry Management 2003; 14:160-172.

[12] Leseure M, Martinez V, Bastl M, Kingston J, Evans S. Challenges in transforming manufacturing organisations into product-service providers. Journal of Manufacturing Technology Management 2010; 21:449-469.

[13] Gebauer H, Friedli T, Fleisch E. Success factors for achieving high service revenues in manufacturing companies. Benchmarking: An International Journal 2006; 13:374-386.

[14] Elfving SW, Washington N, Lienert A, Mänz K, Wilkens U. At a Crossroads: Case Study Analysis of the Organizational Challenges within the Transformation Path to an IPS2. Proceedings of 6th CIRP International Conference on Industrial Product-Service Systems, Windsor; 2014.

[15] Nguyen H N, Schnürmacher C, Stark R.: Research on how to introduce the PSS Engineering into ind. In: ElMaraghy, H. (ed.): Product Services Systems and Value Creation. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems. Volume 16. Elsevier, 2014.

[16] Nguyen H N, Exner K, Schnürmacher C, Stark R.: Operationalizing IPS² development process: A method for realizing IPS² developments based on Process-based project planning. In: ElMaraghy, H. (ed.): Product Services Systems and Value Creation. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems. Volume 16. Elsevier, 2014.

[17] Rank S, Scheinpflug R.: Einführung in das Change Management [Introduction to Change Management]. In: Rank S, Scheinpflug R. editors. Change Management in der Praxis. Beispiele, Methoden, Instrumente [Change Management in practice. Examples, Methods, Instruments] 2nd new edited and extended edition. 15-35. Berlin: Schmidt. 2010

[18] Kotter JP. Leading Change: Why Transformation Efforts Fail. In: Harvard Business School Press. Editors. Harvard Business Review on Change, United States of America, 1998.

[19] Capgemini. Change Management-Studie 2008. Business Transformation – Veränderungen erfolgreich gestalten [Manage Changes successfully]. editors. Capgemini, 2008, URL: http://wirtschaftsplan.ch/images/content/03_forum/pdf_publikationen/Change_Management-Studie_2008.pdf (last accessed: 11.12.2013).